

9. SCREENING OF ALTERNATIVES

This section discusses the screening of remedial alternatives for OU 9-04 sites. In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigation/Feasibility Study (RI/FS) Guidance (EPA 1988), each remedial alternative identified in Section 8 is evaluated against three general criteria: effectiveness, implementability, and cost. A description of each screening criterion follows:

- **Effectiveness**—Effectiveness is the most important aspect of the screening evaluation. This criterion is used to assess the ability of an alternative to provide both short-term and long-term protection of human health and the environment. In this application, short-term refers to the implementation period, and long-term refers to the period thereafter. Also included as a measure of effectiveness is the ability to reduce the toxicity, mobility, and volume of the contaminated material.
- **Implementability**—This criterion is used to assess the technical and administrative feasibility of implementing an alternative. Technical feasibility includes the construction, operation, and maintenance required for implementation of the remedial action. Administrative feasibility includes the regulatory and public acceptance, availability of services, and specialized equipment and personnel requirements. Short-term implementability refers to the implementation period, and long-term refers to the operation, maintenance, and institutional control period thereafter.
- **Cost**—This criterion is used to assess the relative magnitude of capital and operating costs for an alternative during the specified period of active control. Short-term cost refers to the implementation period, and long-term refers to the operation, maintenance, and institutional control period thereafter.

More detailed descriptions of these criteria are given in the guidance for conducting feasibility studies under CERCLA (EPA 1988).

A description of each alternative developed for each site grouping in Section 8 is provided in order to evaluate effectiveness, implementability, and cost. These descriptions are intended to provide sufficient detail to distinguish among alternatives relative to the three screening criteria. Each description provides general information regarding the technologies composing an alternative and the applicability of those technologies to the conditions at the OU 9-04 site groups (i.e., radiologically contaminated sites and sites with inorganics that pose ecological concerns). The following subsections provide a description of each alternative and an evaluation based on the three screening criteria.

9.1 Alternative 1: No Action

Description. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [40 CFR 300.430 (e)(6)] requires consideration of a no action alternative to serve as a baseline for evaluation of other remedial alternatives. No land-use restrictions, controls, or active remedial measures are implemented at the site under this alternative. Thus, contamination is attenuated only through radioactive decay processes. Environmental monitoring can be considered part of a no action alternative during the time

the Department of Energy (DOE) has institutional control of the Idaho National Engineering and Environmental Laboratory (INEEL), which includes the site operational period and at least 100 years following site closure. The no action alternative is applicable to sites where contamination does not exceed the level of unacceptable risk and is in compliance with applicable or relevant and appropriate requirements (ARARs).

Environmental monitoring would be performed to detect contaminant migration and to identify exposures via soil, air, and groundwater. Monitoring results would be used to determine the need for any future remedial actions necessary to protect human health and the environment. Monitoring would be conducted until future reviews of the remedial action determine that further monitoring is not required. Soil, air, and groundwater monitoring activities would be performed under the current ANL-W monitoring and INEEL-wide monitoring programs to the extent practicable. Radiological surveys would be performed at sites where contaminated soil and sediments remain in place as part of this remedial action until WAG-wide comprehensive environmental monitoring programs are implemented. Groundwater monitoring requirements have been identified in the WAG 9 Groundwater Monitoring Plan. Air monitoring would be conducted as part of the ANL-W and INEEL-wide air monitoring programs.

Evaluation. The no action alternative would be easily implemented for all site groups, with minimal costs resulting from radiation surveys. However, results of the baseline risk assessment indicate that some OU 9-04 sites present unacceptable risks to human health and the environment and therefore the no action alternative is ineffective and does not meet Remedial Action Objectives (RAOs). Long-term monitoring costs would be relatively low, assuming the air and groundwater monitoring are performed as part of WAG-wide programs. Estimated costs for the no action alternative for each site are provided in Table 9-1.

9.2 Alternative 2: Limited Action

Description. Alternative 2 consists of the following remedial actions to protect human health and the environment against potential risks associated with OU 9-04 sites:

- Institutional controls:
 - Maintenance of surface soil integrity
 - Surface water diversion
 - Access restrictions
 - Long-term environmental monitoring as for the no action alternative.

Maintenance of surface soil integrity, including repairing effects of subsidence and erosion, would be performed as necessary to prevent exposure of subsurface wastes. Maintenance crews would use the same type of soil present at ANL-W. Surface water diversion measures would be used to prevent ponding on the site. Contour grading, drainage ditches, and other appropriate measures would be used to direct surface water away from the sites to natural or engineered drainage as required.

Table 9-1. Net present value of capital, operating and maintenance (O&M) and total cost for remedial alternatives at OU 9-04 sites.

	Alternative 1	Alternative 2	Alternative 3a	Alternative 4a	Alternative 4b	Alternative 5
	No action ¹	Limited action	Containment w/engineered barrier	Excavation/ disposal at INEEL Soil Repository	Excavation/ disposal at Private Facility	Phytoremediation
Radiologically contaminated sites:						
ANL-01-IWP	Capital =NA O&M = 954,270 Total = 954,270	NA	Capital =745,369 O&M =954,270 Total =1,699,639	Capital =390,614 O&M = 535,544 Total =926,158	Capital =823,947 O&M = 535,544 0 Total =1,359,491	Capital =537,160 O&M = 535,544 0 Total =1,072,704
ANL-09- Canal	Capital =NA O&M = 954,270 Total = 954,270	NA	Capital =3,275,309 O&M =954,270 Total = 4,229,579	Capital =3,056,300 O&M =535,544 Total = 3,591,844	Capital = 7,502,300 O&M = 535,544 Total = 8,037,844	Capital =548,397 O&M = 535,544 Total =1,083,941
ANL-09- Mound	Capital =NA O&M = 954,270 Total = 954,270	NA	Capital =602,340 O&M = 954,270 Total = 1,556,610	Capital= 511,947 O&M = 535,544 Total = 1,047,491	Capital= 1,205,280 O&M = 535,544 Total = 1,740,824	Capital =172,120 O&M = 535,544 Total =707,664
Site with ecological concerns:						
ANL-01 Ditch A, B, and C	Capital =NA O&M = 954,270 Total = 954,270	NA	Capital = 194,848 O&M = 954,270 Total = 1,149,118	Capital = 148,525 O&M = 535,544 Total = 684,069	Capital = 304,525 O&M = 535,544 Total = 840,069	Capital =94,510 O&M = 535,544 Total = 630,054
ANL-01A- MCTBD	Capital =NA O&M = 954,270 Total = 954,270	NA	Capital =174,353 O&M = 954,270 Total = 1,128,623	Capital = 139,251 O&M = 535,544 Total = 674,796	Capital = 284,851 O&M = 535,544 Total = 820,396	Capital = 77,837 O&M = 535,544 Total = 613,381
ANL-04	Capital =NA O&M = 954,270 Total = 954,270	NA	Capital =1,536,749 O&M = 954,270 Total = 2,491,019	Capital =1,031,745 O&M = 535,544 Total = 1,567,289	Capital = 2,373,345 O&M = 535,544 Total = 2,908,889	Capital = 801,638 O&M = 535,544 Total = 1,337,182
ANL-35	Capital =NA O&M = 954,270 Total = 954,270	NA	Capital =87,916 O&M = 954,270 Total = 1,042,186	Capital = 62,436 O&M = 535,544 Total = 597,980	Capital = 97,102 O&M = 535,544 Total = 632,647	Capital = 57,460 O&M = 535,544 Total = 593,004

NA = Alternative does not apply to site.

1 = All cost for limited action are the same because all 6 wells at ANL-W would be sampled.

2 = Alternative would apply to ANL-01A-MCTBD for RCRA hazardous sediments only.

Access to the INEEL is currently restricted for purposes of security and public safety. Since the location of all the OU 9-04 sites are within the boundaries of the INEEL, site-wide access restrictions would limit accessibility. In addition, the existing fence surrounding ANL-W encloses all sites with the exception of ANL-01-Industrial Waste Pond, ANL-04-Sewage Lagoons, ANL-09-Canal, and ANL-09-Mound. The existing security fence equipped with motion detectors and alarms would be maintained and replaced as necessary during the 100-year DOE control period. Installation of additional fences or relocation of the existing fences may also be necessary. Other access control measures may include (but are not limited to) warning signs, assessing trespassing fines, and establishing training requirements for persons allowed access. Land-use restrictions may be specified in the event that government control of the INEEL is not maintained throughout the institutional control period.

Environmental monitoring (described in Section 9.1) would be performed at all sites during the institutional control period. Such monitoring activities would be performed concurrently with any other ongoing monitoring programs at ANL-W and the INEEL. Long-term air monitoring costs would be relatively low, assuming the monitoring would be performed as part of ANL-W and INEEL-wide programs.

Evaluation. The limited action alternative is considered to be easily implemented for both the short- and long-term, since the specified actions are essentially a continuation of the existing management practices conducted at the OU 9-04 sites. The costs associated with this alternative are primarily due to environmental monitoring activities. Soil cover maintenance, surface water diversion, and fence maintenance would be performed only on an as-needed basis. Estimated costs for the limited action alternative for each site are provided in Table 9-1.

This alternative is also considered to be effective for protecting human health and the environment during the 100-year institutional control period. However, after institutional control of the INEEL is discontinued, risks to human health and the environment would be the same as for the no action alternative. Risks to human health and the environment from Cs-137 in the ANL-09-Mound and Cs-137 and Ra-226 in the ANL-01-Industrial Waste Pond, will remain at unacceptable levels after the 100 year institutional control period. However, risks from Cs-137 will decline to acceptable levels at the drainage ditches and disposal pond contamination sites within 130 years due to radionuclide decay. But, the Ra-226 will remain at 2E-04 for 1,000 years. The 2E-04 is just slightly above the upper limit of the NCP of 1E-04 for the most susceptible persons. Therefore, by itself, the limited-action alternative is not considered to be an effective remedy for these sites and will be screened because it does not meet the RAOs. But, some of the tasks in the limited action such as fencing, deed restrictions, and access restriction may be incorporated to any selected alternative in which the contaminated soils remain onsite.

9.3 Containment Alternatives (Alternatives 3a and 3b)

The two containment alternatives (Alternatives 3a and 3b) consist of the following remedial actions to isolate two soil category types at OU 9-04 (radiologically contaminated soil and sites with ecological concerns). Both of the containment alternatives include the following:

- Containment:
 - Protective cover.

- Institutional controls:
 - Long-term environmental monitoring as for the no action alternative
 - Cover integrity monitoring and maintenance
 - Access restrictions
 - Surface water diversion.

The description of the containment alternatives is presented in five parts. Remedial actions common to both containment alternatives are described in Section 9.3.1. Requirements for the preparation of a foundation over the sites of concern before emplacement of a protective cover are presented in Section 9.3.2. Shielding requirements for the protective cover designs are addressed in Section 9.3.3. Finally, each protective cover technology and the associated screening evaluation are described in Section 9.3.4.

9.3.1 Remedial Actions Common to both Containment Alternatives

Remedial actions common to both containment alternatives are described in this section. The institutional controls specified are considered to be the same for each containment alternative. The general description of these remedial actions is therefore applicable to both containment alternatives.

Environmental monitoring, cover integrity monitoring, access restrictions, and surface water diversion would be maintained at both soil categories (radiologically contaminated soil and sites with ecological concerns) during the active institutional control period. Radiation surveys would be required at the radiologically contaminated soil capped sites. Additional surveys across and around the sites would be performed to detect radionuclides mobilized by burrowing animals, erosion or other natural processes. Cover integrity monitoring would be performed across and around at both soil categories (radiologically contaminated sites, and sites with ecological concerns) to assess maintenance requirements due to erosion, cracking, or other observable deterioration of the cover. Access restrictions and surface water diversion measures would be implemented for both containment alternatives. Permanent warning markers would be placed on and around the cover. These institutional controls are assumed to remain in place for at least the 100-year institutional control period.

Although not considered a remedial action, maintenance of the protective cover would be applicable to both containment alternatives. Effective maintenance of the protective cover would be determined on the basis of cover integrity monitoring. The protective cover would likely be monitored frequently during the first 6 to 12 months because potential problems (such as settling or subsidence) are most likely to occur within this period. After the initial 12 months, cover integrity monitoring may be performed annually or semiannually. Maintenance requirements include periodic removal of undesirable vegetation and burrowing animals and filling animal burrows. In addition, unacceptable erosion or subsidence would require repair of the affected area. Maintenance would be performed on an as-needed basis. Operations and maintenance goals will be defined during remedial design.

9.3.2 Protective Cover Foundation

Preparing a stable foundation in a centralized location away from the drainage ditches and Industrial Waste Pond prior to the construction of a protective cover would be essential to ensure long-term integrity of

the containment. The location of the foundation will be selected in an area that is relatively flat and is not in a natural surface water runoff channel. Subsidence could breach the integrity of any cover selected as a remedial action. Therefore, each containment alternative is assumed to include appropriate foundation preparation measures to prevent any differential settling that could result in subsequent failure of the proposed cover.

A centralized location between the radiologically contaminated soil sites would be selected for consolidation of contaminated sediments. The preparation of the foundation would initially consist of clearing and grubbing and finally bulldozing the sites. Currently, available methods for preparing foundations considered applicable to the centralized soil consolidation site include vehicle compaction methods, such as a vibratory steel-wheel drum roller. Vehicle compaction would be performed concurrently with moisture addition, to achieve better compaction and prevent airborne dust. Alternatively, fill material would be placed over contaminated surface soil to prevent generation of airborne contamination prior to vehicle compaction. The most appropriate method of foundation preparation would be determined during the remedial design phase.

9.3.3 Shielding Requirements

INEEL soils and other geologic materials have previously been shown to readily attenuate Cs-137 dispersed in contaminated soil and debris. The primary measure of effectiveness for the containment alternatives is the ability to satisfy the RAO of preventing the external radiation exposure. Each cover design is therefore evaluated for the ability to provide sufficient shielding to reduce the dose rate from the surface of the site to background levels. For the drainage ditches and disposal pond, calculations provided in Table 9-2 show the estimated external radiation exposure excess cancer risks for the various exposure pathways at ANL-W.

9.3.4 Containment Alternative Descriptions

Both of the containment alternatives listed in Section 8 specify use of protective covers in a centralized location for the two soil categories at OU 9-04 (radiologically contaminated sites and sites with ecological concerns), which will prevent human and environmental exposure to contaminated surface soil and buried waste. The difference between the containment alternatives is in the design of the cover specified. No attempt has been made to enhance the basic design concepts of these cover technologies due to the unlimited number of variations possible. However, features from the individual cover designs may be combined in the remedial design phase to optimize containment performance. This section describes each cover technology and the associated screening evaluation for the containment alternative.

9.3.4.1 Alternative 3(a): Engineered (SL-1-Type) Cover.

Description. The uranium mill tailings remedial action (UMTRA) Project has developed and installed variations of an engineered cover design over tailings at inactive uranium mill sites. Variations in these cover designs are the result of site-specific conditions such as climate, native vegetation, availability of materials, and economics. The design criteria for UMTRA covers are as follows (Reith and Caldwell 1990):

- Effective isolation and radon emanation control for up to 1,000 years, to the extent reasonably achievable, and for a minimum of 200 years
- Minimum maintenance
- Prevention of inadvertent human intrusion and minimization of plant and animal intrusion
- Protection of surface water.

Table 9-2. Cover thickness required to reduce 100-year residential external radiation exposure risks to threshold risk ranges.

Risk level	Soil thickness (ft)	Cobble thickness (ft)
1E-04	1.0	0.8
1E-06	2.3	2.0

The engineered cover of Alternative 3a is a rock cover similar to that designed for closure of the SL-1 burial ground. This UMTRA “rock cover” engineered barrier is intended for use in arid climates (Reith and Caldwell 1990).

The simplified cover design consists of four layers of natural media. Figure 9-1 is a conceptual drawing of the design. The materials used in each layer and the functions of each layer are described below:

- The uppermost layer consists of basalt rock rip-rap that serves to prevent inadvertent human intrusion and erosion of the surface.
- The lower layer is a three-layer biointrusion barrier consisting of a layer of gravel overlying a layer of rock rip-rap or cobbles, overlying a fourth gravel layer. The biobarrier provides a mechanical barrier to burrowing animals and an unfavorable medium for the advancement of plant roots.

Each component of the engineered cover (e.g., location and thickness of each layer) would be subject to engineering optimization during remedial design for application to the two soil categories (radiologically contaminated sites and sites with ecological concerns).

Evaluation. This alternative is considered to be highly effective in preventing long-term exposure to both of the soil categories (radiologically contaminated sites and sites with ecological concerns) at OU 9-04. Required soil and cobble shielding as shown in Table 9-2 indicate that these covers would reduce surface exposures to background levels for the radiologically contaminated soils. The covers are designed for long-term isolation with minimal maintenance requirements. The engineered cover for Alternative 3a would be effective in preventing biointrusion and add a high level of inadvertent human or animal intruder protection, by both the mass and impenetrability of material overlying contaminated soils.

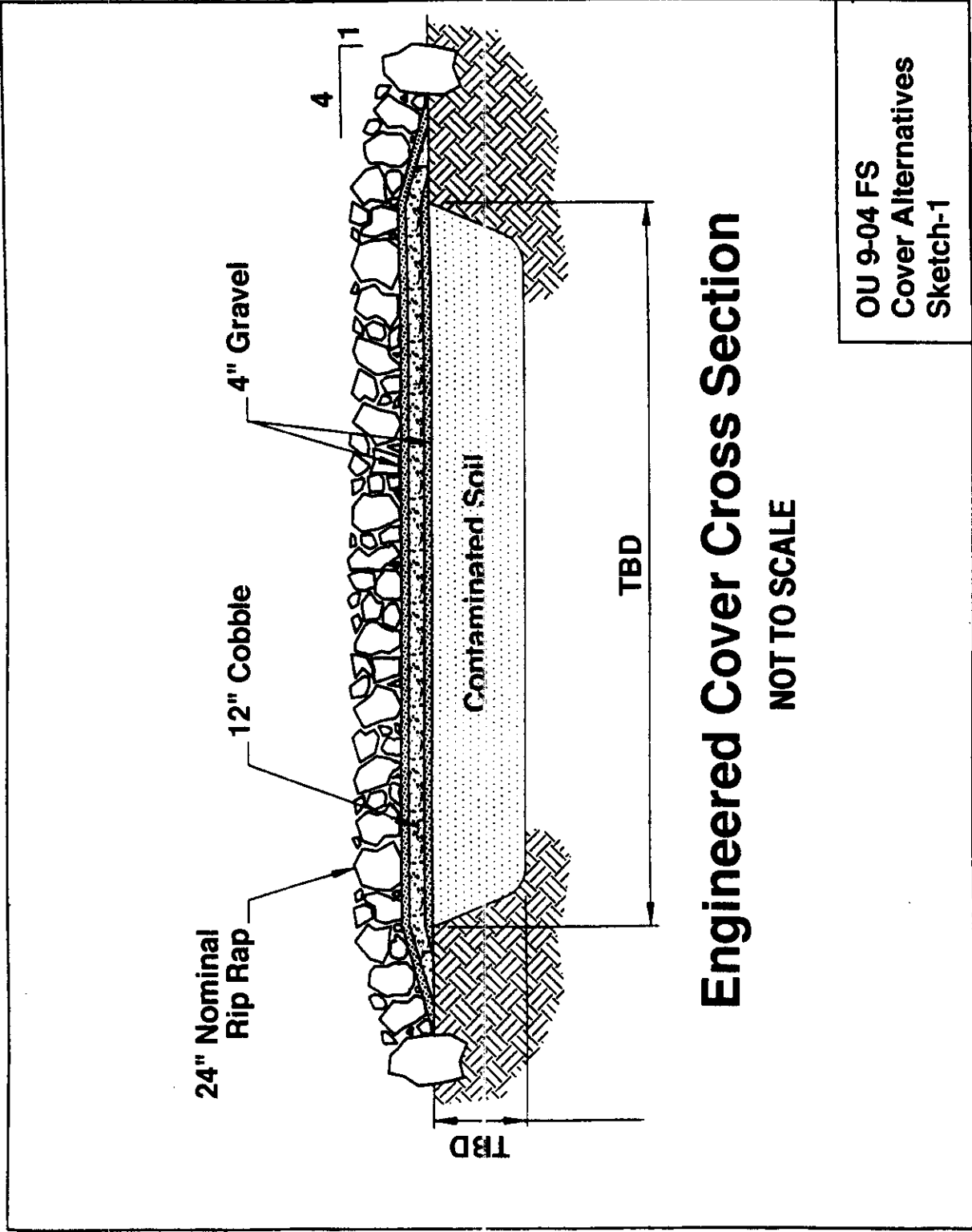


Figure 9-1. Cross-sectional schematic of the engineered cover for Alternative 3a.

Installation of this engineered cover is technically feasible. Short-term effectiveness for protecting human health and the environment is moderate to high, based on worker exposure during construction of the cover. Shielding would be afforded by the 1.0 ft (0.3 m) thick clean soil layer and the foundation layer would provide additional protection during construction of the overlying layers. Both short-term and long-term aspects of this alternative are considered readily implementable. Installation experience and services are available through SL-1 Project experience. Construction materials are readily available onsite. Basalt rip-rap can be obtained from the lava flows that cover much of the INEEL's land surfaces. Gravel may be obtained on the INEEL and/or locally. Long-term inspection and maintenance requirements are considered minimal, but must be accounted for. Long-term monitoring requirements including radiation surveys would be easily implemented during the institutional control period.

The long term costs of monitoring, access restrictions, and surface water diversion are nearly the same for this engineered cover with the impermeable layer as for the engineered cover without the impermeable layer. Long-term air monitoring costs would be relatively low, assuming the air monitoring would be performed as part of ANL-W and INEEL-wide programs. Estimated capital and operating costs for this Engineered Barrier Containment Alternative for each site are provided in Table 9-1.

9.3.4.2 Alternative 3(b): Native Soil Cover.

Description. This type of cap was selected as a process option only for sites with ecological concerns and for Cs-137 contaminated sites. It is not considered as a long-term alternative for the site with the Ra-226 contamination because of its long half-life and $2E-04$ risk at 1,000 years. As shown in Table 7-3 the five ecological sites include; ANL-01, ANL-01A, ANL-04, ANL-09, and ANL-35. Site ANL-01 includes Ditch A, Ditch B, Ditch C, and the Industrial Waste Pond. The Industrial Waste Pond is one of the three radiologically contaminated sites and will stay in that more protective radiologically contaminated soil category. This alternative is being retained for two of the three radiologically contaminated sites (ANL-09-Canal and ANL-09-Mound) that only had Cs-137 contamination that will meet the RAOs in 130 years. The contaminated soil would be excavated from the sites with ecological concerns and consolidated in a central location. This cover consists of a single 10 ft layer of soil obtained on the INEEL, applied in lifts and compacted to 95% of optimum moisture and density. Figure 9-2 shows a schematic of the design. The surface could be completed with a 3 to 5 % slope and vegetated with a crested wheat grass mixture. This type of grass has been found to survive on the INEEL, after establishment, without supplemental water or nutrients. Gravel mulch tilled into the top 6 in. (15.2 cm) of the cover could be used to reduce erosion and promote vegetation. Costs of pit run gravel and native soil obtained on the INEEL are relatively similar, and incorporating a soil: gravel mixture surface would not result in a significant cost variance. A rock armor or other surface covering could also be incorporated during remedial design, if desired. A preconceptual sketch of the design is depicted in Figure 9-2.

Evaluation. This cover would reduce the exposure pathway to the flora and fauna and the two Cs-137 radiologically contaminated sites at OU 9-04. A vegetated surface with a 3 to 5% slope would enhance runoff of precipitation without developing flow velocities that could cause erosion. Actual soil thickness would be determined during remedial design.

The long-term effectiveness of this design for controlling exposures to the flora and fauna is considered moderately effective. The actual reduction in the exposure of the flora and fauna can not be determined since

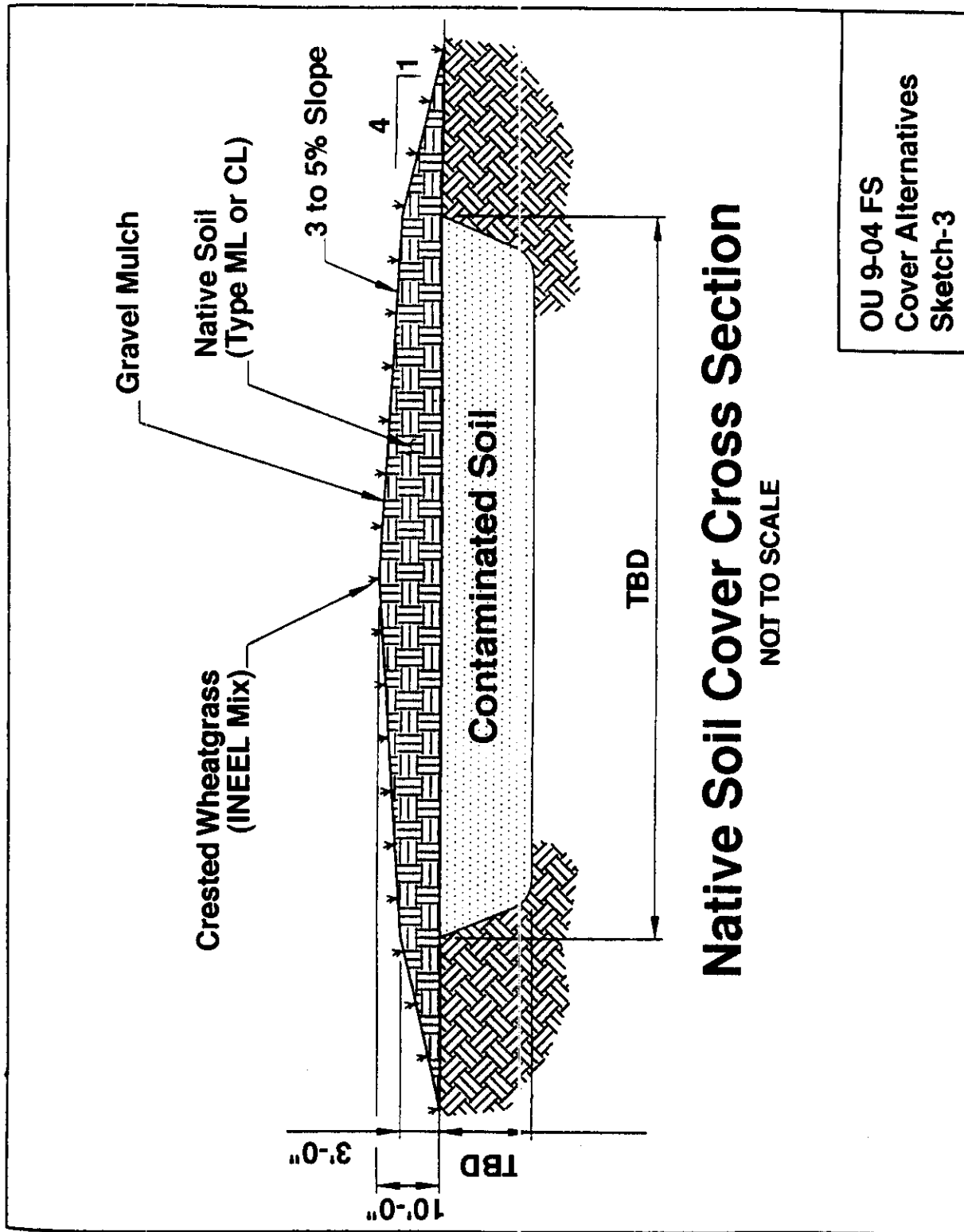


Figure 9-2. Cross-sectional schematic of the native soil cover for Alternative 3b.

animals have a tendency to burrow and tap root of certain plants common to the INEEL have been measured to be 40 feet long. The thickness of the soil layer would also eliminate the potential for inadvertent ecological and human intrusion into contaminated soil. The thickness of the soil layer is also sufficient to inhibit intrusion by many of the burrowing mammals, invertebrates, and most plant species found on the INEEL, into contaminated soils and sediments. However, a thick native soil cover is not considered to be as effective a biobarrier as the engineered rock-gravel cover. In addition, the long-term effectiveness of the native soil cover after the 100 year institutional control period is unknown. Use of crested wheat grass as surface vegetation would also reduce biointrusion by other, deeper rooting plant species for the short term, however it will likely be progressively displaced by other native species over a period of 30–50 years (Keck 1992).

The short-term effectiveness of this alternative is roughly equivalent to that of the engineered covers. The native soil design would be easier to construct than the engineered cover and is therefore regarded as more technically implementable. Long-term inspection and maintenance requirements are considered easily implementable.

The costs of monitoring, access restrictions, and surface water diversion are the same for each containment alternative. Long-term air monitoring costs would be relatively low, assuming the air monitoring would be performed as part of the ANL-W and INEEL-wide programs. Estimated capital and operating costs for the Native Soil Barrier Containment Alternative for each site are provided in Table 9-1.

9.4 Alternatives 4a and 4b: Conventional Excavation and Disposal

Description. Alternative 4a and 4b are being evaluated concurrently because the only difference between the two alternatives is the disposal of the soils. Alternative 4a will evaluate the disposal of the contaminated soil in an INEEL Soil Repository located at the INEEL. While Alternative 4b will use the same excavation and transportation costs to the CFA facility and then incur additional costs of rail transport and tipping fee of a private off-site disposal facility. These two alternatives consists of the following remedial actions to remove and dispose of contaminated soil at the OU 9-04 radiologically and inorganically contaminated sites:

- Removal:
 - Conventional excavation
- Verification sampling
- Transportation
- Contamination control
- Disposal:
 - Low-level radioactively-contaminated soil and debris landfill

- Site restoration
- Environmental monitoring where contaminants would remain in place at depths less than 10 ft (3 m) bls.

9.4.1 Removal

Removal of contaminated soil and debris from the OU 9-04 sites could be achieved using conventional excavation equipment, with standard radiation protection being implemented. The primary components of the retrieval specified for this alternative include the following:

- Real-time gamma surveys during excavation to delineate the extent of contamination exceeding PRGs for the radiologically contaminated sites
- Real-time portable ICP analysis to determine the extent of contamination exceeding the PRGs for the sites with inorganics that pose risks to the ecological receptors
- Excavation with conventional construction equipment
- Characterization of material
- Verification sampling
- Contamination control.

Excavation. This alternative would require excavating contaminated soil and debris from both of the soil categories (radiologically contaminated sites and sites with ecological concerns). After excavation, these sites would be backfilled with clean soil from the borrow pit located near ANL-W. Conventional excavation equipment has been demonstrated to be effective in retrieving radioactive soil and debris in the OU 10-06 Removal Action and other INEEL remedial responses.

Real time gamma surveys could be used to delineate the extent of contamination to be removed as the excavation proceeded. Sodium iodide or germanium detectors could be calibrated to detect radiological contamination present at concentrations above PRGs. As deemed necessary in the remedial design phase, laboratory analysis of an agreed upon number of representative grab samples would be required to verify the real-time assessment. Real-time surveys can reduce the volumes of clean soil removed and mixed with contaminated soil. In addition, real time samples can be analyzed in the field using a portable ICP machine to determine if the inorganic PRGs have been met.

In the event that radiation levels show unacceptable health risks to equipment operators during the excavation, the worker control cabs on the excavation equipment would be modified to enhance operator safety. Direct radiation exposure is reduced by the distance between the operator and the source. The radiation exposure decreases by the inverse square law ($1/d^2$). For example if the operator is five feet away from the source the exposure he would receive is 1/25 of that on the soil. Radiation exposure would be further reduced by using leaded glass windows within the cab. Protection from exposure by inhalation could

be provided by using environmentally controlled cabs that are ventilated to maintain positive pressure within the cab. Additional measures of protection, such as backhoes equipped with long-reach sticks could be used to maximize the separation between the operators and contaminated materials. No additional radiological monitoring would be required for the excavation of the inorganically contaminated sites.

Characterization and Packaging. Alternative 3a (INEEL Soil Repository) does not have any special packaging requirements and would accept bulk shipments of soils. Also, Alternative 3b (off-site) disposal facility for low-level radioactively-contaminated soils, such as Envirocare, does not have packaging requirements and accepts bulk shipments (i.e., trucks or railcars). OU 9-04 contaminated soils and debris are, based on the current sampling results, assumed to meet the facility Waste Acceptance Criteria (WAC) with regards to activity. OU 9-04 site soils are not assumed to be Resource Conservation and Recovery Act (RCRA)-hazardous.

Efficient logistics dictate that instantaneous characterization should occur concurrently with retrieval activities. Real-time monitoring during excavation would serve as a component of characterization. As deemed necessary, laboratory analysis of an agreed upon number of representative grab samples would be required to verify the real-time assessment.

Dump trucks would be positioned near the excavation site such that backhoes can place the contaminated soil directly into the dump truck. When a dump truck has been filled, the operator will use a broom or shovel to remove any soil from the outside of the truck box. A tarp will be unrolled over the truck box and securely fastened to prevent any accidental release of soil in transit. The dump truck will then transport the soil to CFA for disposal at the INEEL Soil Repository (Alternative 4a) or to the rail transfer station for shipment to the private off-site disposal facility (Alternative 4b).

Requirements for disposing of low-level waste (LLW) at the representative facility are defined in the facility license, and are discussed further in Section 9.4.4. Actual shipping methods will be determined during remedial design; however, for FS cost-estimating, rail transport is assumed.

Verification Sampling. Verification sampling, consisting of radiation surveys and soil sampling and analysis, would be performed to confirm that all contamination exceeding PRGs was removed from the site.

9.4.2 Post-retrieval Site Restoration

Following removal of the contaminated soil from OU 9-04 sites, each site would be restored by contouring to the conditions of the surrounding landscape and backfilling excavated areas with clean materials. Backfilled areas would be compacted to prevent future subsidence. Sites would be revegetated as appropriate according to the INEEL Revegetation Plan.

9.4.3 Removal Rates

The rates at which contaminated soil and debris could be retrieved from OU 9-04 sites would depend on the capabilities of the excavation equipment, characterization requirements, material handling equipment, and quality assurance requirements. ANL-W anticipates that a removal rate of approximately 80 yd³ per 8-hour

day is attainable using conventional on-site excavation equipment. The number of excavators and personnel specified to perform removal activities would also influence the rate of waste removal.

The contaminated media would consist primarily of loose sandy silts and is expected to be classified as contact-handled LLW. The relatively shallow depths of contaminated media at OU 9-04 sites [approximately 6 ft (1.8 m) maximum] would allow for excavation using front end loaders and backhoes.

9.4.4 Disposal Distance and Method

Alternative 4a and 4b would both use trucks to transport the soils from ANL-W to the CFA. These costs are considered to be the same for both alternatives. But, additional costs would be associated with Alternative 4b for the rail transport of the soils from the CFA to the Envirocare in Clive, Utah. Road distance from ANL-W to CFA is approximately 20 miles, and rail distance from CFA to Clive is approximately 300 miles. Transport of soils from ANL-W to CFA would require the use of public roads.

Requirements for disposing of LLW at the INEEL Repository have not been officially established but are assumed to be the same as those of an off-site disposal site. The requirements for disposing of LLW at Envirocare are defined in the facility license (# UT 2300249). The facility material qualification and acceptance process are summarized as follows:

1. Waste must be fully characterized by the generator.
2. If RCRA hazardous waste, the Environmental Protection Agency (EPA) Hazardous Waste Code(s) must be listed in Envirocare's permit.
3. If the waste is RCRA hazardous or subject to land disposal restrictions (LDR) apply the waste must meet applicable RCRA treatment standards.
4. Waste must have radioisotopes and activities within the limits of Envirocare's license.
5. Waste must have physical properties that meet requirements of Envirocare's license (no free liquids, manageable debris, optimum moisture content).
6. Incoming waste must arrive properly transported and packaged and must be within characterization and tolerances.

The Envirocare license specifies activity limits for TRU radionuclides, rather than a limit for total TRU. Envirocare will accept low-level soils shipped in bulk (i.e., rail cars or dump trucks), therefore specialized packaging is not required. Envirocare requires that soils be adjusted to optimum moisture content before shipment, in order to maximize compaction when disposed at the landfill. Given that water sprays would be used to control fugitive dust emissions during excavation, this likely does not present an added cost. Soils excavated from OU 9-04 sites are assumed to meet the WAC for Envirocare subject to the characterization results.

9.4.5 Evaluation

The short-term effectiveness of both Alternatives 4a and 4b for protecting human health is judged to be moderate, relative to other alternatives. Equipment operators and site personnel would potentially be exposed to minor radiological exposures during removal activities, however these exposures could readily be controlled using standard radiation control measures. Short-term protection of the environment is expected to be high because adequate contamination control measures are specified. Long-term protection of human health and the environment for Alternatives 4a and 4b is judged to be highly effective because contaminated soil and debris would no longer exist at any site. Toxicity, volume, and mobility of disposed contaminants would not be reduced by this alternative.

Short-term technical implementability of these alternatives is considered moderate. Proposed excavation equipment (including necessary modifications to protect operators) are currently available. Characterization, packaging, transportation, and disposal of contaminated materials all use currently available technologies. ANL-W currently has trained personnel and standardized equipment available to support this activity. Long-term implementability is considered high, since the contamination will be removed. Long-term inspection and maintenance requirements are considered minimal, but must be accounted for. Environmental monitoring as for the no action alternative would still be applicable for the first twenty year review period.

The short-term cost of these alternatives would be high. The extra costs associated with Alternative 4b off-site transportation and disposal are higher than those for Alternative 4a. Both Alternatives would have significant costs associated with the safety analyses, satisfying ARARs, and operational and capital costs. The primary capital cost associated with this alternative would be disposal facility fees and transportation costs. Operation and maintenance costs are considered high during the excavation and disposal period because of the radiological considerations involved with safety and decontamination, but these operations would take less than 1 year to complete. Long-term monitoring costs would be low, assuming all contamination would be removed from all sites. Long-term air monitoring costs would be relatively low, assuming the air monitoring would be performed as part of the ANL-W or INEEL-wide programs. Estimated capital and operating costs for the removal and disposal alternatives are provided in Table 9-1.

9.5 Alternative 5: Phytoremediation

This treatment alternative is being evaluated for its use at both the radiologically contaminated sites and those sites with inorganics that pose risks to the ecological receptors. The effectiveness of the technology varies by contaminant and actual site conditions. Bench-scale testing would have to be performed prior to its use at the ANL-W contaminated sites.

Description—Phytoremediation, is an emerging cleanup technology for contaminated soils. Phytoremediation is defined as the engineered use of green plants, including grasses, forbs, and woody species to remove, contain, or render harmless contaminants such as inorganics, organics, and radioactive compounds in soil. Phytoremediation takes advantage of the unique and selective uptake capabilities of plant root systems, together with the translocation, bioaccumulation, and contaminant storage/degradation abilities of the entire plant body. Plant-based soil remediation systems can be viewed as biological, solar-driven, pump-and-treat systems with an extensive self-extending uptake network (the root system) that enhances the

below-ground ecosystem. After the plant has bioaccumulated the contaminants, the plant matter is harvested using conventional farming practices. The plant biomass is then dried, baled, and transported to an incinerator for disposal. The mass of the harvested plant matter is approximately two orders of magnitude less than the mass of soil that is typically excavated for off-site disposal. An advantage of using phytoremediation is that the plants utilize the most readily available nutrients and contaminants (most mobile) from the soil. By removing these mobile nutrients and contaminants from the soil, they are not able to leach or be accumulated by other non-harvested plants or animals. The remaining nutrients and contaminants have a stronger bond to the soils and are less likely to leach from the soil. Phytoremediation systems have been used for years to treat acid mine drainage or municipal sewage through the use of engineered wetlands. This technology has the advantages of being both low-tech and low-cost while still satisfying the CERCLA guidance to treat wastes to reduce the toxicity or mobility of a contaminant rather than simply containing them.

Evaluation—The short-term effectiveness of this alternative for protecting human health is high. Most of the WAG 9 sites are within a security fence which would limit both the human and ecological exposures. Exposure of workers and environmental receptors to metals during the planting, irrigating, harvesting, transportation, and disposal would be controlled using administrative and engineering controls including appropriate personal protection equipment (PPE). Long-term protection of human health and the environment is high. If the laboratory bench-scale tests conducted for various plant species on the ANL-W soils show bioaccumulation of the radiological and inorganic contaminants, it is assumed that the long-term effectiveness would reduce all risk to human health and the environment above allowable levels.

Technical and administrative implementability of this technology is considered medium to high. This technology has not been previously used on the INEEL. The possible exception to this is the INEEL Landfarm where microbes are used to breakdown petroleum contaminated soils. Bench-scale testing would be conducted during the winter of 1997-98 to determine this technology's implementability for WAG 9 soils and contaminants. No long-term care would be required at the site, assuming all contamination was removed.

Short-term costs of the treatment process component of this alternative are low. The long-term costs depend on the rate of bioaccumulation of the plant species. Typical costs for this technology are approximately one-tenth of those of typical containment alternatives.

9.6 Screening of Alternatives Summary

In the preceding subsections, each remedial action alternative was defined in order to provide sufficient qualitative information to allow differentiation among alternatives with respect to effectiveness, implementability, and cost. Results of these evaluations are now used for comparing alternatives within each general response action (GRA) relative to each other. Screening on a relative basis allows for either eliminating alternatives from further evaluation or retaining alternatives for detailed analysis. The purpose of this screening is to refine the list of alternatives to be retained for detailed analysis.

Alternatives may be screened from further consideration on the basis of relative effectiveness within a GRA or if an alternative is not considered implementable. An alternative can only be screened on the basis of cost when the relative effectiveness and implementability of other alternatives are equal. Alternatives can also be screened on the basis of unjustifiable cost relative to increased effectiveness or implementability. The

screening process is only a preliminary evaluation, and alternatives are generally retained unless a clear basis for rejection is identified (EPA 1988).

9.6.1 No Action Alternative 1

As required by the NCP, the no action alternative is retained for detailed analysis to serve as the baseline for comparison of remedial action alternatives. Review of the BRA leads to the conclusion that "no action" is not an acceptable alternative on the basis of mitigation of identified source-to-receptor pathways.

9.6.2 Limited Action Alternative 2

The limited-action alternative is considered to be effective for protecting human health and the environment during the 100-year period of institutional control. The Cs-137 and Ra-226 radionuclide contaminants will remain at risks of $1\text{E-}04$ for 130 years and 1,600 years respectively. While the inorganics that pose unacceptable risks to the ecological receptors will remain indefinitely. However, once the specified institutional control actions (i.e., subsidence correction, surface water diversion, access restrictions, and environmental monitoring) are either no longer conducted or enforced, the risk to human health and the environment would be equivalent to "no action." Results of the BRA indicate that the overall risks associated with the two categories of soils at OU 9-04 (radiologically contaminated sites and sites with ecological concerns) will still exceed $1\text{E-}04$ or a hazard index (HI) greater than 1 after 100 years. Therefore, this alternative is screened from further consideration on the basis of effectiveness.

9.6.3 Containment Alternatives 3a and 3b

Both containment alternatives (3a and 3b) are considered to be effective in preventing exposure from the radiologically contaminated sites in the short-term. Alternative 3a provides better long-term protection for exposure of long lived nuclides (Ra-226) than Alternative 3b. Alternative 3a adequately prevents the biointrusion for the sites with ecological concerns, while Alternative 3b does not prevent growth of tap roots into the contaminated soil. Long-term care costs are similar for both engineered covers 3a and 3b. Alternative 3a will be retained for further evaluation in the detailed analysis of alternatives Section 10. While Alternative 3b will be screened because it does not provide adequate ecological protection and only minimal long-term effectiveness for the radionuclides.

9.6.4 Removal/Disposal Alternatives 4a and 4b

Although safety and shielding measures can be implemented to protect equipment operators, conventional excavation would result in higher short-term human health risks than any of the other alternatives considered. Short-term costs for removal/disposal alternatives are expected to be significantly greater than for the two retained engineered containment alternatives, however, long-term care costs are zero for OU 9-04 if all contamination is removed. Alternative 4a short-term costs are less than those of Alternative 4b because of the elimination of extra transportation costs (rail car) and reduced disposal fee. Long-term effectiveness would also be higher than the on-site containment. Excavation and disposal Alternatives 4a and 4b are therefore retained for detailed analysis.

9.6.5 Phytoremediation Alternative 5

This alternative would decrease the volume of contaminated media removed from the ANL-W facility versus the on-site containment and off-site disposal. In addition, this alternative actually treats the soils and satisfies the requirements of CERCLA that it is preferential to treat the soils to reduce the toxicity or mobility of the contaminants. Short-term costs are typically one-tenth of those for typical excavation and disposal technologies. Long-term costs are eliminated after the soil meets the established PRGs. Long-term effectiveness of phytoremediation is higher than for other alternatives because the contaminants have been removed from the soil versus simply eliminating the exposure pathway. This alternative is retained for further consideration.

9.6.6 Alternatives Eliminated from Further Analysis

The screening process identified alternatives with favorable evaluations of effectiveness, implementability, and cost. Based on the screening results, Alternative 2 (limited action) and Alternative 3b (native soil containment) are eliminated because they do not meet the established RAOs. Alternative 1 (no action) does not meet the RAOs but will be further evaluated in the FS because it is required to assess the benefits that are gained by the other alternatives. All other alternatives are retained for further analysis.

9.7 Groundwater Monitoring

Monitoring is assumed to be required regardless of the disposition of OU 9-04 sites described in this report. Cost estimates for 20 years of monitoring of 5 wells for the suite of analytes outlined in the WAG 9 Groundwater Monitoring Plan, twice a year, with QA samples are provided in Table 9-1. The applicability of continued RI/FS review for OU 9-04 will be evaluated during the five year review periods.

9.8 References

- EPA, 1988, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, EPA/540/G-89/004, Interim Final, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, October.
- Keck, J. F., 1992, *Evaluation of Engineered Barriers for Closure Cover of the RWMC SDA*, EDF # RWMC-523, January.
- Reith, C. C., and J. A. Caldwell, 1990, *Vegetative Covers for UMTRA Project Disposal Cells*, presented at the Department of Energy Remedial Action Program Conference, Albuquerque, New Mexico, April.
- Valentich, D. J., 1993, *Full-Scale Retrieval of Simulated Buried Transuranic Waste*, EGG-WTD-10895, EG&G Idaho, Inc., September.